Comments on ”Chattering-free digital sliding-mode control with state observer anddisturbance rejection”

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Vincent Acary[†], Bernard Brogliato[‡♡], Yury V. Orlov[♠]

***Abstract*—An unfortunate mistake in the proof of Proposition 1 in [1] is corrected.**

In the proof of Proposition 1 in [1], the third and fourth items in the followingt list:

- If $x_k > ah$ then $\tilde{x}_{k+1} = x_k - ah$ and $\text{sgn}(\tilde{x}_{k+1}) = 1$,
- If $x_k < -ah$ then $\tilde{x}_{k+1} = x_k + ah$ and $\text{sgn}(\tilde{x}_{k+1}) = -1$,
- If $0 > x_k > -ah$ then $\tilde{x}_{k+1} \in (-ah, 0)$, and $\text{sgn}(\tilde{x}_{k+1}) = -1$,
- If $0 < x_k < ah$ then $\tilde{x}_{k+1} \in (0, ah)$, and $\text{sgn}(\tilde{x}_{k+1}) = 1$.

have to be replaced by the unique item:

- If $x_k \in [-ah, ah]$, then $\tilde{x}_{k+1} = 0$.

which readily follows from the fact that $\tau_{k+1} = \text{proj}([-1, 1]; \frac{x_k}{ah})$, and inserting this into the first line of Equation (4) in [1]: $\tilde{x}_{k+1} = x_k - ah\ \tau_{k+1}$. This is in turn equivalent to the first two lines of Equation (4) in [1], which form a so-called *generalized equation* (since $\text{sgn}(0) = [-1, 1]$) with unknown $\tilde{x}_{k+1}$. It is illustrated on Figure 1, where dashed lines represent the function $\tilde{x}_{k+1} \mapsto \tilde{x}_{k+1} - x_k$, and the solid piecewise-linear curve is the graph of the set-valued map $\tilde{x}_{k+1} \mapsto -ah\ \text{sgn}(\tilde{x}_{k+1})$. Case 1: $x_k < -ah$, case 2: $x_k = -ah$, case 3: $x_k \in (-ah, ah)$, case 4: $x_k = ah$, case 5: $x_k > ah$. Once $\tilde{x}_{k+1}$ and τ_{k+1} are known, the third line of Equation (4) in [1] can be used to advance the algorithm to step $k + 1$.

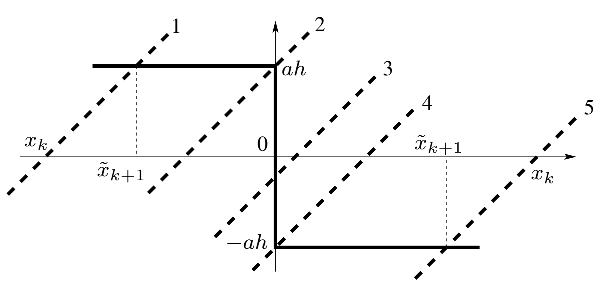

Fig. 1. The variable $\tilde{x}_{k+1}$ as a solution of the generalized equation $\tilde{x}_{k+1} - x_k \in ah\ \text{sgn}(\tilde{x}_{k+1})$.

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References

[1] V. Acary, B. Brogliato, Y. Orlov, "Chattering-free digital sliding-mode control with state observer and disturbance rejection", IEEE Transasctions on Automatic Control, vol.57, no 5, pp.1087-1101, May 2012.